student should commit to memory is separately printed, and precedes the first chapter. Beginners will find it better on their first reading to omit the articles specially marked for this end, and also to make selections from the examples. It would be hard to find a better introduction to plane trigonometry book.

LETTERS TO THE EDITOR.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Music, Rhythm, and Muscle.

IN your issue of January 18, you refer (on p. 271) to an article by Dr. Wilks in the *Medical Magazine* (which I have not seen), in which the learned author points out that music is not to be regarded in its origin as a purely spiritual faculty, but that it admits of a physiological explanation. This discussion is in itself a most interesting one. Dr. Wallace, in his well-known discussion of the relations of music to the other faculties of man, has raised this very question, or one closely allied to it. Wallaschek, as quoted by Dr. Wilks and yourself, asserts that "rhythm, or keeping time, lies at the very foundation of the musical sense." Rhythm again, he says, "can be referred to muscular contraction and relaxation," the "muscular sense being the measure of time," so that the muscular sense is intimately bound up with the idea of music. "Not in the different passions of the mind, but in muscular action, therefore, music appears to have had its origin."

My purpose in addressing you is to point out that these opinions receive a remarkable and very beautiful illustration in the history of Greek dance and rhythm, so far as these are known to us. We know but little of Greek music in the stricter sense of this word, and this perhaps for the very reason that music was not then separated from choral intonation and movement. The strophé and antistrophé of the Greek chorus, which terms we usually apply to the musical phrases sung during a movement, are primarily, of course, not these strains but the evolutions themselves, the dancing towards the one side of the orchestra or the other. Now we do know from the metrical analysis of Greek dramas and odes what these rhythms were, and we can thus probably infer the character of the music proper. By the study of Greek rhythms we shall thus find a method of tracing the genesis of music in its most elaborate modern forms from dancing and footing it in any kind of measure. Dr. Wilks well points out that muscular movement is essentially rhythmical: we may go farther and say that all movement, even the rush of falling water, is rhythmical.

The monotony of the recurrence of identical periods or colons would soon be felt, and we find accordingly that efforts are made by all early people to vary the measures. The use of two and four simple feet would soon pall, and was accordingly broken up in the Greek drama by threefold and more complex metres, as, for instance, by Pindar in his Epinikian odes. This "threefold form," says a recent writer, finds an almost exact counterpart in most of the figures of Bach's "Wohltemperirtes Klavier," and the "modern sonata has the same form on a very extended scale," the first part and its repetition corresponding with the strophé and antistrophé of the Greeks, and the second part with the epode. These curious parallels and essential similarities may be traced much farther and into elaborate detail, as is shown in part by the writer I have quoted, Mr. Abdy Williams, in the *Classical Review* for 1893 (p. 295). Mr. Williams's article, which well deserves a careful reading, is based upon the important discovery of a treatise on rhythm by Aristoxenus of Tarentum. Aristoxenus was a favourite pupil of Aristotle, and flourished about 300 B.C.; he wrote also a treatise on harmony, which less concerns us here, and he was "not only a musician, but a man of the widest culture and knowledge." Soon after the time of Aristoxenus the dependence of music on metre, which in its turn is a notation of choral movement and but a regulation of the rhythms of various muscular movement—the dependence, I say, of music on metre gave way to the ascendancy of accent. Accent, and not quantity began to form the basis of the rhythm. Strict measure thus became less obviously the basis of music and poetical rhythm; but, says Mr. Williams, "upon the ruins of the ancient measured music arose a new and magnificent art, now known as 'Plain Song' or 'Gregorian Music,' the rhythmical construction of which is based on the natural laws of phrasing." (Compare strophé and antistrophé.)

With the disuse of plain song arose again the old metrical rhythms, but now so dissociated from choral evolutions that we have forgotten their muscular origin. The early modern composers recovered the elaborate rhythms once founded on choric phrases, but under the name of "form," and "by following the instincts of their genius, unconsciously brought about a renaissance of the natural rhythms and musical forms known to the ancient Greeks, developing them by the aid of modern resources, while adhering to certain definite principles which on examination are found to agree with those enunciated 2000 years ago by Aristoxenus of Tarentum." These, I need not repeat, were almost directly based not upon rhetorical, but upon muscular rhythms. The simpler and ruder the musical sense, the more brief and simply bipartite, or two-legged, must be the recurrent rhythms, as the popular tunes of our street organs and music halls tell us daily; the more relieved and elaborated rhythms of Bach and Beethoven need a more sustained attention and a more cultivated apprehension, while the rhythms of Wagner are so postponed in their resolutions, and so broken in their variety, that perhaps few even of good musicians can follow them with any consciousness of muscular measure, or even of "form." Therefore we call them "highly spiritualised," and forget whence they are originally derived.

Cambridge, January 28. T. CLIFFORD ALLBUTT.

P.S.—Since writing this letter, Prof. Roy has drawn my attention to the statement that if a pencil be taken in the right hand, a sheet of paper placed below it, and the hand thrown into a rapid automatic dotting action, as the paper is drawn forward the resulting row of dots will be found to be a uniform number per second—five or seven, I forget which—and thus for all persons alike there is the basis of rhythm.

The Cloudy Condensation of Steam.

THE publication in your pages[1] of Mr. Shelford Bidwell's lecture on "The Cloudy Condensation of Steam," at the Royal Institution in May last, calls for a few remarks from me. As the points I have to refer to are principally personal, I shall be as brief as possible.

In discussing the effects of electrification on the condensation of a steam jet, Mr. Bidwell, after pointing out that though it has been shown that small particles of matter are thrown off by the electrical discharge, says that—"Yet it is remarkable that Mr. Aitken . . . gives no countenance to the nucleus theory." He then informs his hearers that he imagines I have abandoned my conclusions regarding the action of dust. It is very difficult to understand Mr. Bidwell's objection to me not countenancing the nucleus theory to explain the phenomena, as in the very next paragraph he shows I was correct in not ascribing the change in the jet when under electrification to dust particles, and gives an experiment to prove it. His experiment is different from the one on which I founded my conclusion. In some experiments made when working at this subject there did not seem to be a possibility of the dust produced by the electrical discharge getting to the jet. Take, for example, the following experiment:—The steam jet was allowed to issue from the side of a polished metal ball of about 3 c.m. diameter. This arrangement was adopted to prevent any discharge of electricity from the nozzle. At one side of the jet was placed an electrified body at a distance of about 10 c.m.; and at about the same distance on the other side of the jet was placed a flame. As no air passed either from the flame or from the electrified body to the jet, it seemed impossible the effect could be due either to particles of metal from the conductor or to particles of dust from the flame. The conclusion, therefore, was that the effect on the jet could be produced by electricity without the aid of dust. It, however, seems highly probable that the dust produced by the discharge of electricity may have some effect in such experiments as those described by Prof. Barus, in which the air from the terminals from which the discharge is taking place is carried to the jet. Prof. J. J. Thomson

---

[1] NATURE, December 23, 1893.

© 1894 Nature Publishing Group

has since shown[1] that the increased density of the jet on electrification is only partly due to the cause to which I attribute it, namely, the electrical repulsion preventing the coalescence of the drops, as he proves that the electrification of the jet overpowers the surface tension, and so promotes the formation of small drops, and in this way assists in increasing the density of the condensation.

Mr. Bidwell's misunderstanding of my position is greatly due to an impression he seems to have that I attribute all cloudy condensation to the presence of dust particles. Now, if he will turn to my first paper on this subject,[2] he will find that the effect of the vapours of hydrochloric, sulphuric, and nitric acids, *active* vapours, mentioned in his lecture, have all been referred to, and experimented with, as well as many other substances, so that I was well aware of these causes of condensation. Further, he will find in the paper referred to, as well as in another of a later date,[3] that it is possible to produce cloudy condensation without the presence either of dust or a vapour capable of forming a nucleus with water vapour, or even the abnormal condition due to electrification, all that is necessary being a sufficiently high degree of supersaturation.

Darroch, Falkirk. JOHN AITKEN.

The Os Pedis in Ungulates.

PROF. EWART, in a recent paper,[4] describes the os pedis or "coffin bone" of the horse as consisting to a large extent of a bony cap developed from connective tissue around, and quite independent of the terminal phalanx. This throws an entirely new light on one of the most remarkable bones of the horse's skeleton, and is especially interesting to veterinarians. Having a fœtal calf (about 6½ months) in my possession, I was led, on reading Ewart's paper, to examine the digits, and wish now, in a word, to state the result.

I found each digit provided with a bony cap similar to that figured by Ewart from his 35 c.m. horse embryo. On making a longitudinal vertical section of one of the digits, the investing cap could easily be distinguished from the phalanx proper; and, further, I noticed a large deposit of osseous matter in what may be termed the diaphysis (shaft) of the terminal phalanx, and an indication of a second ossific centre at its apex. This affords additional proof that the third phalanx in ungulates, as in man, consists partly of membrane bone and partly of cartilage bone, and that it in all probability develops from several centres.

I hope soon to publish a number of observations on the structure and development of the digits in ungulates.

A. E. METTAM.

Royal Veterinary College, Edinburgh.

A Brilliant Meteor.

A METEOR of extraordinary splendour was seen here this evening at 7.45. It appeared vertically under the Pole star, at an elevation of 40°, and, after pursuing a path that sloped down to the west at an angle of 30°, disappeared silently under Cassiopeia.

The incandescent mass had an apparent volume equal to that of a good-sized orange. It gave out a bluish-white light that brilliantly lit up, for about four seconds, the grounds and buildings of the College.

The glowing mass was followed by a long, conical, crimson train ending in a wisp of condensed vapour resembling smoke.

The sky was clear, starlit, and moonless at the time.

M. F. O'REILLY.

The Training College, Waterford, January 31.

THE VATICAN OBSERVATORY.

THE report recently issued by the Vatican Observatory (*Pubblicazioni della Specola Vaticana*, Fasciculus iii.) is the best that has been prepared by Father Denza, and in abundance of matter and fineness of execution, it compares favourably with that of any observatory. The first report was published in 1891, but neither that nor the one of 1892 contains so much evidence of work done as the bulky tome last issued. The observatory, as it is at present constituted, only dates back to 1889; but previous to that, it passed through so many vicissitudes that a brief outline of its history may be of interest.

It is recorded that an observatory tower was erected by Pope Gregory XIII. in connection with the reform of the calendar, some time previous to 1582. The tower was intended for astronomical observation, and there is every reason to suppose it was the first celestial watch-tower built in Rome. The following translation of an extract from the *Nautica Mediterranea* of B. Crescenzi, published in Rome in 1607, clearly shows that the room at the top of the tower was used for astronomical purposes:—"When the sun arrives at the tropic of Cancer its rays enter a little hole which Ignatius Danti has had made for that purpose in the roof of the apartment which Pope Gregory XIII. had erected upon the Belvedere Gallery, and the rays only enter the hole once a year, when the sun is furthest from the equinox, after which he turns and goes back." Danti appears to have marked a meridian line upon a marble table in the tower, and meridian observations were made until about 1644, but the observatory was afterwards neglected, and remained so for about a century and a half. It was only towards the end of the last century that an attempt was made to renew the astronomical work. Cardinal Zelada had a large meridian circle constructed, and furnished the observatory with some good astronomical instruments, among which was a telescope by Dollond. As the observatory was not available for public instruction, it was decided to establish another at the Roman College, and the new observatory was erected in 1787, though observations had been carried on at the College long before.

In 1789 the Vatican Observatory commenced a new epoch in its history. Philip Gili began his directorship in that year, and, in addition to making astronomical observations, initiated researches in magnetism and meteorology, and other branches of terrestrial physics. The observatory kept well apace with the times until the death of Gili in 1821, but after that it became quite disorganised. All the instruments and records were dispersed, and the observatory itself was entirely deserted until about 1870, when it was transformed into a residence.

Before passing to the third epoch in the "eventful history" of the Vatican Observatory, a few remarks upon the Observatory of the Roman College may be of interest, especially as the relations between the two institutions are not generally well understood among astronomers. According to Father Cortie, who has kindly furnished most of the following information upon this matter, the Roman College Observatory dates back at least to 1572. It belonged to the Society of Jesus, and consisted in the beginning of a few rooms set aside for astronomical studies. Scheiner, of sun-spot fame, Clavius, the author of the Gregorian reform of the calendar and the observer of Tycho Brahé's Nova of 1572, de Gottingues, who observed Jupiter's spots and the comets of 1664, 1665, and 1668, Boscovich, and other renowned astronomers were connected with it. There still exists in the Kircher Museum of the College a meridian line traced by Boscovich, and the same astronomer drew up the plans for a new observatory, but they were never carried into effect, on account of the troubles in France and Spain, during which the Society of Jesus was suppressed. During the period of the suppression, the observatory was directed at first by J. Callandrelli, who in 1773 built a square tower at the eastern angle of the facade of the College, and placed in it a zenith-sector and a meridian circle, the gifts of Cardinal Zelada and Pope Pius VII.

---

[1] *Phil. Mag.* October, 1893.

[2] "Dust, Fogs, and Clouds." (*Trans.* Roy. Soc. Edin., vol. xxx. part i.)

[3] "On the Numbers of Dust Particles in the Atmosphere." (*Trans.* Roy. Soc. Edin. vol. xxxv. part i.)

[4] "The Development of the Skeleton of the Limbs of the Horse." (*Journal of Anatomy and Physiology*, January, 1894.)

© 1894 Nature Publishing Group